

# **TDK-Lambda HV Power Supply Acceptability for the 500 kW Klystron Modulator System**

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9/25/2014

## **Summary**

The currently installed Model RCS-3000 High Voltage Power Supplies for the 500 kW Klystron Modulator System is no longer manufactured by Converter Power, Inc. The TDK-Lambda Model 402 Series 5 kV High Voltage Supply was evaluated as a suitable replacement. The modifications required to existing modulator hardware and the results of the acceptance test are included in this document.

## **Specifications**

The TDK-Lambda HV Power Supply meets all criteria of Specification # 0231.00-ES-281419:

1. Input Voltage: 208/220 VAC, 3 phase, 50-60 Hz
2. Output Voltage: 0 – 4 kV
3. Charging Rep Rate: 15 Hz
4. Charge Rate: 2 kJ/s avg
5. Local Control: Power ON/OFF, HV ON/OFF, Status Displays, Voltage & Current displays, LOCAL/REMOTE Switch, Local Voltage Control
6. Remote Interface: Voltage Control (0 – 10 V), Voltage Output Monitor (0 – 10 V), Current Output Monitor (0 – 10 V), HV ON/OFF, Inhibit Circuit, Status Indicators

## **Modifications**

### **1. Signal Interface Board**

The Converter Power HV power supply required a ‘pulsed’ dry contact to turn on the high voltage, while the TDK-Lambda supply requires a ‘constant on’ dry contact. The ‘constant on’ functionality for remotely turning on the high voltage of the TDK-Lambda supply is accomplished by removing U1 (96LS02) and connecting pins 6 & 7 together on U2 (75452), on the Signal Interface Board (0231.00-ED-281501).

Additionally, a 22 k $\Omega$  / 82 k $\Omega$  voltage divider is connected between ferrite T3 and Signal Interface Board pin PI-27A. This modification allows for a 0 – 10 V reference voltage to produce 0 – 4 kV on a 5 kV High Voltage Power Supply.



- The table below shows the new configuration of Burndy-to-DB25 cable, for connecting the modulator Charging Supply Controller Chassis to the TDK-Lambda HV power supply.

Signal Name	Description	I/O	Signal Infrf		RSC-3000	TDK-Lambda
			P1_Pins	Burndy	D_Conn	D_Conn
Reference Volts	0-10 VDC for 0-5 KV	I	A27	A	11	22
Common	Control Ckt Return		C27	B	13	12
15V	+15V through 100 k $\Omega$	O	A24	E	9	14
AC_Inhibit	5-15V Inhibit CS Operation	I	A25	F	22	7
CS_ON	Turn HV On	O	A28	G	6	8
CS On/Off		I	C28	H	20	14
CS_OFF	Turn HV Off	O	C30	J	19	
15V	+15V through 100 k $\Omega$	O	A11	P	18	25
Off Status	Lo - Z when HV output is Off	O	A12	R	4	23
Inhibit Status	Lo - Z when CS is Inhibited	O	A13	S	14	3
Interlock Status	Lo - Z when Interlock is Open	O	A14	T	15	17
On Status	Lo - Z when HV output is On	O	A15	U	16	10
Overload Status	Lo - Z when CS has Summary Fault	O	A16	V	17	19

### Acceptance

The operability of the TDK-Lambda 402 Series HV Power Supply was verified, using a spare Signal Interface Board, C.S. Controller Board (0231.00-ED-281500), and C.S. Controller Chassis (0231.00-ED-504).

The following signals were used to simulate a running modulator on the spare C.S. Controller Chassis:

- +5 V to Controller Chassis BNC connector B2 (CS On/Off)
- +5 V to Controller Chassis BNC Connector B6 (AC\_Inhibit)
- 5 Vp-p, 15 Hz pulse (30 ms length) to Controller Chassis BNC connector B6 (Charge)
- +5 V to Controller Chassis BNC connector B9 (CS Stop)
- +5 V to Controller Chassis connector P5 (to SRM P3), pins 1, 3, & 5 (+) and 33, 34, & 35 (-), for C.S On, Off, & Reset, respectively.
- 0 – 10 V reference voltage to Controller Chassis connector P10 (to SRM P4), pins 1 (+) and 6 (-).

Other connections made for Acceptance Test:

- 208 VAC, 3 phase power to TDK-Lambda HV Power Supply
- Power Supply HV Output to 22  $\mu$ F, 14 kVDC Capacitor, via 100 $\Omega$  Resistor
- Burndy-to-DB25 cable, from C.S. Controller Chassis to HV power Supply 'Remote' connector
- 2000:1 Ross Divider to Capacitor terminals, for monitoring  $V_{cap}$ .
- Shorted the 'Interlock' terminals on the back of the HV power supply.
- Installed Ground Sticks (Resistive and Direct) for removing energy from test capacitor, following deenergization of the HV power supply.

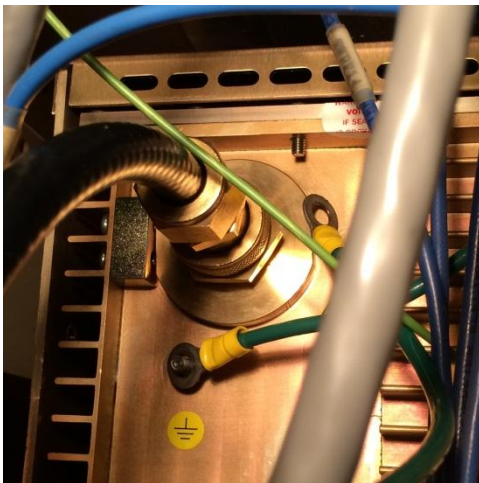
After the above connections were made and simulations voltages applied, the HV power supply was energized. The bench supply voltage was increased to 10 VDC, in 0.1 V increments, and the HV power supply output was verified to 4 kV, via local indication and the Ross Divider. During the transition from 0 – 4 kV, all status indications and read-backs were verified as operable.

### Installation

On 8/21/14, the TDK-Lambda 402 Series HV power supply was installed into vernier klystron modulator system. The following picture shows the construction of the HV cable, connecting the HV power supply to the modulator pulse forming network (PFN).



The following pictures show the connections of the HC cable to HV supply and PFN (left & right, respectively).



Note that in the PFN connection picture (right), the shield of the HV cable is connected to ground. Following initial power-up, this ground connection was removed due to necessity of the PFN cabinet to be ‘floating’ above ground.

Additionally, to facilitate remote operation of the HV power supply, the ACNET digital parameter KVCSON was modified from an active high TTL pulse to active high TTL constant when KVCSON is ‘turned on’.